A Diſcourſe concerning Weather, *&c. By the learned Dr* Garden *of* Aberdene. *Written by way of Letter, to Mr.* Henry Scougall, Profeſſor *of* Theology *in that* Univerſity; *and communicated to the* Phil. Soc. *of* Oxford, *by the reverend Dr* Middleton, Provoſt *of the* Kings College in Aberdeen.

Sir.

I Am ſorrie, I can give you no better ſatisfaction in this account you demand of the Conjecture we had lately occaſion to talk about, my other neceſſarie diverſions and the few obſervations I have made, render it the more imperfect. However ſince 'tis your pleaſure, you ſhall have it as it is; and if it come afterwards to be cleared & confirmed by the joynt obſervations and ſentiments of others, it may paſs for an Aero-Statical Hypotheſis of the various changes of the Weather.

We have been hitherto to ſeek for an intelligible account of the aſcent of Vapours, the ballancing of the Clouds and their dropping down again into rain; and the wind bloweth where it liſteth, and we know not whence it cometh, nor whither it goeth; and 'tis like our conjectures about the more immediate cauſes of all theſe may be ſtill uncertain Gueſſes, yet the works of God are ſought out of all thoſe that take pleaſure in them: and the late known properties of the Air, *viz.* its weight and Spring have made men more inquiſitive in this matter then formerly: and you know how by the obſervations of the Baroſcope they perceive that the Atmoſpheres Gravity is not always the ſame, and are ſurpriz'd to ſee the Mercury ſubſide for the moſt part in Foggy, rainy, windy, or cloudy, weather; and on the contrary to aſcend and be higheſt in calm and clear ſeaſons. I ſhall not ſtay here to tell you the Conjectures of others about this, but ſhall only take occaſion to conſider how this may ſerve to put us in the right rode in our enquiries about the Variations of the weather.

And firſt the Air being a fluid, we are to take notice of thoſe properties which it has in common with other fluids, and thoſe wherein it differs from them, in ſo far as they concern this matter. It agrees with all other fluids in this that it Gravitates; and again it has this peculiar property (which is not ſo much obſerv'd of other fluids,) that its *ſpecifical Gravity* is not always the ſame. Now you know according to the certain rules of the ballancing of fluids amongſt themſelves, every fluid ſpecifically lighter then another will aſcend and emerge above it, and every fluid ſpecifically heavier will deſcend and ſubſide below. Thus if a Glaſſe in whoſe bottom there is oyl be fill'd with water, the oyl will emerge above, but if the water be drawn out with a Siphon, and the Air (a ſpecifically lighter fluid,) ſucceed, the oyl will ſubſide again. Now there is ſome certain proportion between the ſpecifical Gravities of the fluid of Air, and of that which aſcends in Vapours and falls down again into rain; and if this proportion were ſtill the ſame, 'tis like we would have no commixture of thoſe fluids, but the Vapours would either always float above or always ſtay below. But this proportion of their ſpecifical gravity is frequently changed; for it is known that water when warm and tepid is lighter then when it is cold (and yet perhaps too the ſmall particles of it (if figured according to *des Cartes* his conjectue,) are more capable of aſcending in Vapours in froſt then at another ſeaſon, as being more extended, and ſo having a larger portion of the fluid of Air to bear them up;) and the daily obſervations of the different heights of the Mercury in the Baroſcope do make appear that the Atmoſpheres gravity is not always the ſame. And now from theſe known properties may be eaſily deduced a ſtatical account of the riſing of Vapours, their being carried in the Air in Clouds and their falling down again into rain.

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For if we may be allowed to ſuppoſe that when the Atmoſphere is heavieſt, there is ſome ſuch proportion between its ſpecifical gravity, and that of the fluid of Vapours, as there is between water and oyl; the Vapours according to the known laws of fluids muſt needs aſcend, and ſo long as this proportion continues they muſt needs float above in the Air: but when the Atmoſpheres gravity is chang'd, the Vapours muſt fall down again. Thus you ſee how eaſily this may be accounted for, and how reaſonable this ſuppoſition is from the known properties of theſe fluids.

Now let us ſee whether this accords with obſervation and experience. And firſt as to the aſcent of Vapours, I do not know any determinate Inſtrument that will Indicate their aſcent as certainly as the Baroſcope does the change of the Air's weight (for our common Hygroſcopes are not very exact, and beſides I ſuppoſe their change by moiſture ſhews rather the falling then the riſing of Vapours) yet there are two or three obſervations which ſeem certain Indications of their aſcent: as firſt, if the Horizon and the remote Hills ſeem Smoakie and inconſpicuous, ſo that nothing can be ſeen at any diſtance, and that tho' the Heavens be not cloudy, but clear, and tho' there be no Fog nor yet any Cap of Clouds upon the Hills (which do rather indicate the falling of Vapours,) again if when you look to any diſtant part of the Country round about you, it appear all in an undulating motion (and this you know our Countrie People call by the name of Summer Colts in the Air,) this ſeems to be a ſign of the plentifull riſing of Vapours, for this is only occaſioned by looking through an unequall waving Medium, which makes frequent inflections of the beams of light, as you ſee any object ſeems to have a tremulating motion in all its parts when you look upon it through Smoak. Another Indication of the aſcent of Vapours ſeems to be the copious riſing of Steams above waters, mariſh grounds and fens,

which

which is frequently ſeen in froſts and in cool nights in Summer. To theſe I may add the redneſs of the Sun (ſo as to be eaſily look'd upon, and moon, a conſiderable time before their ſetting or after their riſing. Now ſince I have had occaſion to make obſervations of the Bacoſcope, I have always taken notice of all theſe, when the Mercury was riſing and conſequently in the increaſe of the Atmoſphere's gravity; I have then frequently obſerved how inconſpicuous and as it were Smokie the Horizon & remote Hills would appear tho' there were no Clouds in the Air, and in what a tremulous motion remote objects ſeem'd to be, aud how copiouſly the Steams did ariſe from waters and mariſhes, and how red and eaſie to be looked on the Sun was for a conſiderable time before ſetting. But on the contrary when the Mercury has been low in the Baroſcope and ſo the Atmoſphere's gravity leſs, I have obſerved none of theſe effects, but the remote Hils were clear and diſtinct (unleſs ſome times a Cloud had falln down upon them,) and no waving to be obſerved in the Air nor Steams from the waters. I know not whether I may add here a conjecture about the great light & the Capræ ſaltantes which are ſome nights to be ſeen in the North. I have taken notice of them uſually when the Mercury has been high in the Baroſcope, and then they appearing in that quarter of the Heavens where the Sun is at that time below the Horizon, this has given me occaſion to think that perhaps the Steams of Vapours may have aſcended ſo far in the Atmoſphere as to be beyond the Earth's ſhadow in that part of the Horizon, and ſo by refracting the beams of light towards us to occaſion that light and thoſe Capræ ſaltantes. It may be conſidered alſo whether the red skies in the Evening which betoken fair weather, do not proceed from the height of the Clouds occaſioned at that time by the encreaſe of the ſpecifical gravity of the Atmoſphere.

Now as to the falling down of the Vapours again, it is viſible

viſible by their gathering into thick and dark Clouds; by the falling down of Clouds and Miſts on the tops of Hills, and thick fogs in the Air, and by their dropping down into rain, ſnow, &c. and that theſe do uſually fall out only when the Mercury ſubſides a little, and conſequently when the Atmoſphere's gravity is leſs, is the conſtant obſervation of thoſe who have had occaſion to take notice of the changes of the Baroſcope. And thus you ſee how this Hypotheſis for the aſcent of Vapours and falling down of rain, grounded on the changes of the Atmoſphere's gravity anſwers daily obſervation & experience.

Againſt this it may be objected, that it is obſervable many times that even when the Mercury in the Baroſcope is riſing there will be rain, and particularly ſometimes in North Eaſt Winds. To this I anſwer that the Vapours will fall down into rain not only when the ſpecifical gravity of the atmoſphere is leſſened, but alſo if the Clouds have been carried for ſome while towards one quarter of the Heavens by the Winds, & then if the Winds do ſuddenly change into another quarter theſe Vapours, which were formerly ſcattered into ſmall particles and ſo did eaſily float, are ſuddenly driven together into little drops and ſo muſt needs fall down into rain, and therefore the falling of rain while the Mercury is riſing is obſervable only upon the ſudden change of contrary Winds.

But let us conſider in the next place whether thoſe frequent commotions in the Air which we call Winds, may not be accounted for upon the ſame Principles, and this we ſhall do as formerly by looking into the nature of a fluid in the general and of the Air in particular, as to fluids in generall, that known definition of Archimedes is univerſally acknowledged, Quod earum partium minus preſſæ expellantur a magis preſſis, ſo that if there be any portion of a fluid of a far leſſe preſſure and reſiſtance then the reſt, the whole fluid runs in a current thither, till all be reduc'd to an Æquilibrium. This principle is ſo univerſally

verſally received and known that we need not ſtay to make it good. Now as to the fluid of Air in particular, it is evident, as has been already made appear that 'its preſſure is not always the ſame. And 'tis very probable (which Experience will determine by making joynt obſervations of the Baroſcope in ſeverall places of the Earth at the ſame time,) that the Air's gravity is not alike chang'd throughout the whole Atmoſphere in an Inſtant; but that the Mercury may have ſubſided in the Baroſcope, and conſequently the Air become lighter, at *London*, for example, when there is no ſuch change obſerv'd at *Paris* or *Edinburg*. Now this ſuppoſition doth give us an intelligible account of Winds from the known nature of fluids. For when the Air becomes ſpecifically lighter in one place, or its preſſure leſſened, the Neighbouring parts of the Atmoſphere whoſe weight is not thus leſſened, run thither in a Current till the Atmoſphere thereabouts be reduc'd to an Æquilibrium again;and according to the portion of Air thus chang'd and the leſſened or acquired degrees of the weight and ſpring, the currents and Winds are ſtrong or weak, of a long or ſhort continuance.

Now Obſervation and Experience do agree with this, the Mercury being found to ſubſide for the moſt part in the Baroſcope at the riſing of Winds ; at leaſt it is obſerv'd to be in motion, and either riſing or falling, or conſequently there is a change in the Atmoſpher's preſſure at that time. And thus we have an Intelligible and Aero-Statical account, of the aſcent of Vapours, of their falling down again into rain, and of the currents and Impetuoſity of Winds, from this known property, the Variation of the Atmoſphere's gravity.

But I acknowledg the great difficulty remains ſtill how to account for the different changes of the ſpecifical gravity of the Atmoſphere ; and to this I ſhall at preſent only ſay theſe two things, 1. That it is very ordinary and allowable

lowable to endeavour a rational account of the ſeveral Phenomena of a portion of matter from ſome known property of that body which it makes up or which acts upon it, tho' there cannot preſently be given a Mechanical account of that property its ſelfe. Thus all the appearances, which were formerly reſolv'd into a *Metus Vacui*, are now accounted for by the weight and ſpring of the Air, tho' the Air's weight and ſpring be not reſolv'd into their true Mechaniſm. And in this all I aim at is to offer the moſt natural and rational method for reſolving the ordinary changes of the weather, and to make appear that 'tis more eaſie and intelligible to account for the falling of rain and the impetuoſity of Winds by the change of the Atmoſphere's gravity, then to explicate the change of the Air's weight from the rain and Winds.

But now as to the thing its ſelf, there can hardly be expected a ſatisfactory account till we come to know the cauſe of gravity in general, and of the Air's weight in particular; and therefore I ſhall only here offer 2 or 3 hints which perhaps may incite others to conſider it more narrowly and 1. it is now almoſt generally acknowledg'd that there muſt needs be a fluid much more ſubtil then common Air and of a far greater preſſure then Air which is the cauſe of the continuity and coheſion of all terreſtrial bodys, and in which the Air ſeems as it were to float and to have the ſame relation to it, as the Vapours do in and have to the Air, and therefore if we could reach its nature and properties it might be conſidered what influence this may have upon the change of the Air's gravity. Or 2. Seeing the Infuſion of one Liquor into another in Chymical preparations will alter its ſpecifical gravity ſo that the bodys which were formerly born up in it, will fall down and be precipitated (as the particles of Gold floating through *Aqua Regis* will be precipitated by the infuſion of another Chymical Liquor,) it may be conſidered whether plenty of Nitrous Steams or ſome ſuch mixture

mixture may not alter the Air's ſpecifical gravity. Or 3. We may poſſibly come to a nearer reſolution of this by conſidering the influence which the Heat and Cold have upon the Air's ſpring. The Air you know has this peculiar propertie which is not ſo much obſerv'd of other fluids, that it is indu'd with Elaſticity as well as gravity, and therefore we are to conſider what influence the change of its ſpring may have upon the change of its weight, and it ſeems evident that the encreaſe of its ſpring doth diminiſh its weight, and the leſſening of its ſpring will encreaſe it: for upon the encreaſe of the Air's ſpring, the Air is rarefied, and ſo a leſſer portion of it preſſes upon the ſubjacent fluid, but when it is leſſen'd the Air is condenſed, and ſo a greater portion of it preſſes upon the ſubjacent body. For example let us ſuppoſe the ſpringy particles of Air, to be like to the ſpringy hairs of Wooll, or the ſpring of a Watch; and that many Millions of rows of them go to make up the Cylinder of Air which from the top of the Atmoſphere preſſes upon the Mercury in the Baroſcope and keeps it ſuſpended to the height of 30 Inches; let us ſuppoſe this Air rarified, ſo that all its ſpringy particles expand themſelves, and therefore ſhut off of this Cylinder ſome Thouſands of thoſe rows; this Cylinder being now made up of a far leſſer number of thoſe rows of particles, muſt needs have a leſſer preſſure upon the Mercury, ſo that it will ſubſide perhaps to 29. And thus it continues till the Air's ſpring be weakned, and ſo the particles crowded again into narrower room. Now if this be found to hold in the Theory, Experience ſeems very well to anſwer it; for I have hitherto obſerved that in Cold weather and ſharp Froſts the Mercury riſes higheſt in the Baroſcope, and if the forreign meaſures agree with ours it is uſually higher here then in *France* or *Italy*.

I ſhall here after all ſubjoyn two or three obſervations which may ſerve to confirm what has been ſaid. The firſt

firſt is of the courſe of the weather under or near the Line. I have read in the 2d, and 4th, parts of *Purchas* his *Pilgrims*, (and I doubt not but later Travellers atteſt the ſame truth,) that in *Braſil* and *Guiana* in *America*; in *Guinea*, *Congo* and *Æthiopia* in *Africa*; in the *Eaſt-Indies* and the *Maldive Iſlands*, they have almoſt continual floods of rain from about the beginning of *May* to the end of *Auguſt*, which they call their Winter, and the reſt of the Months of the year fair and clear weather, which they call their Summer; ſo that when the Sun is neareſt to them they have conſtant rains, and when remoteſt, fair weather. And this I impute amongſt other cauſes to the extraordinary rarefaction of the Air and leſſening of its ſpecifical gravity there at that time, ſo that the Vapours in the Neighbouring parts of the Air do all flow thither, and deſcend as it were in floods of rain. And as this is reckon'd to be the cauſe of the Inundation of the Nile and ſome other Rivers, ſo perhaps this may be the reaſon alſo why thoſe *Countries* which are Neighbouring to them, and ſomewhat remoter from the Line, ſuch as *Ægypt* and the like, have ſeldom or never any rain.

My 2d, Obſervation is of the Baroſcope *viz*. that when the Wind is North, North-Eaſt, or North-Weſt, the Mercury ever riſes, and ſo the Air is heavier, but when the Wind comes from the South, South-Eaſt, or South-Weſt, it falls and ſo the Air's gravity is leſs; by which we may ſee what Influence the Cold and Heat have upon the Air's weight; and you know a Cold Wind is ſaid to drive the Sails of a Ship much more forcibly then a Warm.

My 3d, Obſervation is of an Experiment of the Honourable Mr. *Boyle* as I find it ſet down in the Philoſophical Tranſactions *Numb*. 63. Pag. 2048, 2049. I made, *ſaith he*, by Diſtillation a blood red Liquor, which cheiflly conſiſted of ſuch ſaline Spirituous particles as may be obtain'd from the maſſe of blood in human bodys; this Liquor is of ſuch a Nature that if a Glaſs Viol about half filled with it be kept well ſtopt, the red Liquor will reſt as quietly as any ordinary one, without ſending up any Smoak. But if the Viol be unſtopt ſo that the external Air be permitted to come in, within a quarter of a Minute or leſs there will be elevated a copious white Smoak, which will not only fill the upper part of the Glaſs, but plentifully paſs out into the open Air, till the Viol be again ſtopped. And a little after he addes ------- If the unſtopt Viol were plac'd in our Vacuum, it would not emit any viſible Steams at all, nor ſo much as appear in the upper part of the Glaſs its ſelf that held the Liquor; whereas when the Air was by degrees reſtor'd at the ſtop-cock, the returning Air would preſently raiſe the Fumes firſt into the vacant part of the Viol, whence they would aſcend into the Capacity of the Receiver; and likewiſe when the Air that was requiſite to ſupport them was Pumped out, they alſo accompanied it as their unpleaſant ſmell evinced, and the red Spirit, tho' it remain'd unſtopped, emitted no more fumes, till the new Air was let in again; ſo far He. Such you ſee was the proportion between the gravity of the Vapours of this red Liquor and the Air, that the Air being in its ordinary degree of gravity theſe Vapours did aſcend; but the Air's gravity being much leſſened in the Receiver by the Pumping out a great deal of it, and ſo expanding the ſprings of the reſt, it was not able to elevate thoſe Vapours.

Thus, *Sir*, in obedience to your Commands, I have ſcribled over my thoughts about this matter, and you ſee how neceſſarie it is for eſtabliſhing a Theory of the weather, to have a more Univerſal correſpondence in obſerving joyntly the Various changes of the weather in diſtant places; the ſeveral quarters of the Wind, their ſtrength, the time of their riſe and continuance; the various

rious changes of the Baroſcope obſerved by an Univerſal meaſure agreed upon; the changes of ſeal'd and open Thermometers, of Hygroſcopes, &c. And the Latitudes and Longitudes of the places. I doubt not but there may be ſeveral Inquiſitive Perſons engag'd in making ſuch remarks; and if it were thought fit to employ the excellent Correſpondence which has been eſtabliſhed throughout the Learned World in publiſhing ſuch joynt obſervations, as they do many uſefull things in other parts of the Hiſtory of Nature, we might poſſibly arrive at a more determinate and uſefull knowledge of the nature and cauſes of Vapours, Wind, Rain, &c. and the various alterations of the weather, and find out this *Proteus* in all its changes.